Minerals Council South Africa

FORMULA SHEET

SUBJECT: CERTIFICATE IN ROCK MECHANICS **PAPER 1:** THEORY **SUBJECT CODE: COMRMC** **EXAMINATION DATE: 4 OCTOBER 2022** **TIME**: **14H30 TO 17H30**	**EXAMINER:** SZ PETHÖ **MODERATOR:** O RAKUMAKOE **TOTAL MARKS:** [100] **PASS MARK:** (60%)

NUMBER OF PAGES: 4

THIS IS THE FORMULA SHEET THAT MUST BE USED FOR RMC PAPER 1

FORMULAE SHEET

1. $F = mg$ $\sigma = F/A$
2. $q_v = \rho gh$
3. $\beta_o = \frac{(1+\sin\varphi_i)}{(1-\sin\varphi_i)}$
4. $RQD = 115 - 3.3\,Jv$
5. $\tau = C_o + \mu\sigma_n$
6. $\sigma_1 = \sigma_c + \beta_o\sigma_3$
7. $\mu = tan\varphi_i$
8. $\mathbf{s = e^{\frac{(RMR-100)}{9}}}$
9. $\mathbf{m = m_i\, e^{\frac{(RMR-100)}{28}}}$
10. $\sigma_1 = \sigma_3 + \sqrt{(s\sigma_c^2 + m\sigma_c\sigma_3)}$
11. $k = \frac{\upsilon}{1-\upsilon}$
12. $K = \frac{E}{3(1-2\upsilon)}$
13. $w = \frac{1}{2}(\sigma_x\varepsilon_x + \sigma_y\varepsilon_y + \sigma_z\varepsilon_z + \tau_{xy}\gamma_{xy} + \tau_{yz}\gamma_{yz} + \tau_{zx}\gamma_{zx})$
14. $Q = \frac{1}{2}\sigma\varepsilon \times Volume$
15. $\varepsilon = \Delta\ell / \ell_o$ $E = \sigma/\varepsilon$ $\varepsilon_r = -v\varepsilon_a$
16. $\sigma_{xx} = \left[\frac{E}{(1+v)(1-2v)}\right]\left[(1-v)\varepsilon_{xx} + v\left(\varepsilon_{yy} + \varepsilon_{zz}\right)\right]$
17. $\sigma_{yy} = \left[\frac{E}{(1+v)(1-2v)}\right]\left[(1-v)\varepsilon_{yy} + v(\varepsilon_{xx} + \varepsilon_{zz})\right]$
18. $\sigma_{zz} = \left[\frac{E}{(1+v)(1-2v)}\right]\left[(1-v)\varepsilon_{zz} + v\left(\varepsilon_{xx} + \varepsilon_{yy}\right)\right]$
19. $\sigma_x = \frac{E}{1-\nu^2}(\varepsilon_x + \nu\varepsilon_y)$ $\sigma_y = \frac{E}{1-\nu^2}(\varepsilon_y + \nu\varepsilon_x)$
20. $\sigma_1 = \frac{E}{1-\nu^2}(\varepsilon_1 + \nu\varepsilon_2)$ $\sigma_2 = \frac{E}{1-\nu^2}(\varepsilon_2 + \nu\varepsilon_1)$

21. $\sigma_n = \sigma_1 cos^2\theta + \sigma_2 sin^2\theta$ $\tau_{nm} = -\frac{1}{2}(\sigma_1 - \sigma_2) sin2\theta$

22. $\sigma_1 = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}\sqrt{\left[(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2\right]}$

23. $\sigma_2 = \frac{1}{2}(\sigma_x + \sigma_y) - \frac{1}{2}\sqrt{\left[(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2\right]}$

24. $\theta = \frac{1}{2} arc\tan\left[2\tau_{xy}/(\sigma_x - \sigma_y)\right]$ $\tan 2\theta = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$

25. $\tau_{max} = \frac{1}{2}(\sigma_1 - \sigma_2)$

26. $\sigma_{x'} = \sigma_x cos^2\theta + 2\tau_{xy} \sin\theta \cos\theta + \sigma_y sin^2\theta$

27. $\sigma_{y'} = \sigma_x sin^2\theta - 2\tau_{xy} \sin\theta \cos\theta + \sigma_y cos^2\theta$

28. $\tau_{x'y'} = \frac{1}{2}(\sigma_y - \sigma_x) \sin 2\theta + \tau_{xy} \cos 2\theta$

29. $\varepsilon_{x'} = \varepsilon_x \cos^2\theta + \gamma_{xy} \sin\theta\cos\theta + \varepsilon_y \sin^2\theta$

30. $\varepsilon_{y'} = \varepsilon_x \sin^2\theta - \gamma_{xy} \sin\theta\cos\theta + \varepsilon_y \cos^2\theta$

31. $\gamma_{x'y'} = (\varepsilon_y - \varepsilon_x) \sin2\theta + \gamma_{xy} \cos2\theta$

32. $\varepsilon_{x'} = \varepsilon_x \cos^2\theta + \gamma_{xy} \sin\theta\cos\theta + \varepsilon_y \sin^2\theta$

$$\varepsilon_1 + \varepsilon_2 = \frac{2}{3}(\varepsilon_{0^\circ} + \varepsilon_{60^\circ} + \varepsilon_{120^\circ}),$$

33. $$(\varepsilon_1 - \varepsilon_2)^2 = \frac{4}{3}(\varepsilon_{60^\circ} - \varepsilon_{120^\circ})^2 + \frac{4}{9}(2\,\varepsilon_{0^\circ} - \varepsilon_{60^\circ} - \varepsilon_{120^\circ})^2$$

$$\tan 2\theta = \frac{\sqrt{3}(\varepsilon_{60^\circ} - \varepsilon_{120^\circ})}{2\,\varepsilon_{0^\circ} - \varepsilon_{60^\circ} - \varepsilon_{120^\circ}}$$

34. $\varepsilon_x = \frac{1}{E}[\sigma_x - \nu(\sigma_y + \sigma_z)]$ $\gamma_{xy} = \frac{1}{G}\tau_{xy}$ $G = \frac{E}{2(1+\nu)}$

$\varepsilon_y = \frac{1}{E}[\sigma_y - \nu(\sigma_x + \sigma_z)]$ $\gamma_{yz} = \frac{1}{G}\tau_{yz}$

$\varepsilon_z = \frac{1}{E}[\sigma_z - \nu(\sigma_x + \sigma_y)]$ $\gamma_{zx} = \frac{1}{G}\tau_{zx}$

35. $\varepsilon_1 = \frac{1}{2}(\varepsilon_x + \varepsilon_y) + \frac{1}{2}\sqrt{\left[(\varepsilon_x - \varepsilon_y)^2 + \gamma_{xy}^2\right]}$

36. $\varepsilon_2 = \frac{1}{2}(\varepsilon_x + \varepsilon_y) - \frac{1}{2}\sqrt{\left[(\varepsilon_x - \varepsilon_y)^2 + \gamma_{xy}^2\right]}$

37. $\sigma_r = \frac{1}{2}q(1+k)\left(1-\frac{R^2}{r^2}\right) - \frac{1}{2}q(1-k)\left(1-\frac{4R^2}{r^2}+\frac{3R^4}{r^4}\right)\cos 2\theta$

$\sigma_\theta = \frac{1}{2}q(1+k)\left(1+\frac{R^2}{r^2}\right) + \frac{1}{2}q(1-k)\left(1+\frac{3R^4}{r^4}\right)\cos 2\theta$

$\tau_{r\theta} = \frac{1}{2}q(1-k)\left(1+\frac{2R^2}{r^2}-\frac{3R^4}{r^4}\right)\sin 2\theta$

$\sigma_z^t = \sigma_z^v + \nu\,(\sigma_r^i + \sigma_\theta^i)$